IQ and Economic Volatility

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Do countries with higher levels of national IQ have less volatile growth of real economic output compared with lower-IQ countries? This issue has not been addressed. Using a large sample of countries, a simple bivariate correlation indicates that IQ and economic volatility are negatively related. Estimating a regression model of volatility that includes IQ with a number of control variables, the estimated coefficient on IQ is consistently negative and significant. On average, a one-standard deviation increase in IQ is associated with about a 30 percent reduction in economic volatility. The evidence indicates that higher IQ countries have more stable economies.

INTRODUCTION

Do countries with higher levels of national IQ experience less volatility in the growth of real economic output compared with lower IQ countries? It seems like a natural question to pose, though to my knowledge it has not been addressed in the large and growing literature that links intelligence to economic activity. And this is somewhat surprising since it is an important question: Although it remains an unsettled issue, there is much evidence to suggest that more volatile growth is associated with lower average growth rates in real GDP per capita across countries. This volatility and its attendant reduction in economic growth hinders improvement in standards of living. Jalan and Ravalion (1999), Pallage and Robe (2003), and Wolfers (2003), among others, find that macroeconomic volatility is costly in terms of welfare losses, especially to poor households.

A pioneering study is Ramey and Ramey (1995). Using a cross section of countries, they found that higher volatility in economic growth rates, measured using annual growth rates in real GDP per capita, were associated with lower average growth rates. That is, countries with more volatile growth rates tended to have lower long-term economic growth. This qualitative result has become accepted generally, though Dawson (2015) finds that Ramey and Ramey's negative relationship between growth volatility and average growth turns positive (though insignificant) if the sample of countries is restricted to the OECD. This is, no doubt, because OECD countries, on average, tend to be low growth volatility countries and, statistically, this is likely to yield an insignificant correlation.

The Ramey and Ramey findings prompted a number of additional studies seeking to explain economic volatility. Two early works in this area are Easterly and Kraay (2000) and Easterly, et al. (2003). They focused on an array of likely economic candidates to explain economic volatility, the short-list of culprits including trade openness and financial development. Loayza, et al. (2007) and Haddad, et al. (2012) represent more recent work that also find trade openness is associated with lower growth volatility. Several studies (e.g., Satyamath and Subramanian, 2004; Fata and Mihov, 2005; Mobarrak, 2005; Dawson, 2010, 2015; Jetter, 2015; and Tang and Leung, 2016) find that improved democratic institutions and/or smaller size of government tends to lower growth volatility.

These findings provide a direct link to why one might consider IQ as a source of lower growth volatility. this comes from the fact that there is ample evidence (Rindermann, 2018 provides the best overview of the relevant evidence to date) that countries with higher average national IQ also tend to have better democratic institutions, better legal systems, and better systems of property rights. Higher IQ countries are more likely to have the institutional structures that promote more stable economic environments—and thus economic growth—in which individuals thrive. Rindermann notes that "Cognitive ability [higher IQ] enhances the individual's understanding of concepts and causal relationships, it increases insight, foresight, and rationality." (Rindermann, 2013, p.1) If true, then we should expect to find that countries with higher national IQ, on average, should also experience lower growth volatility as they pursue policies that reduce the probability and amplitude of economic fluctuations.

This study thus extends previous analyses in which growth volatility is explained using standard economic variables and previous crossover work in psychology and economics that found IQ a significant factor explaining economic growth (e.g., Jones and Schneider, 2006). Hanushek and Woessmann (2008) also should be recognized. This divergence between adequately measuring human capital accumulation using education—years in school, degree obtained, etc.—and "cognitive skill" has recently been noted by the OECD in its Survey of Adult Skills (2016). It also addresses Rindermann's (2018) argument that higher IQ countries are better able to establish policies that combat economic "bads," such as high inflation. It is of course possible that not instituting policies may deliver smaller fluctuations in economic activity. The evidence to date suggests that some degree of intervention—monetary and fiscal policy—lessens the severity and perhaps the incidence of economic fluctuations. If higher IQ nations are better able to recognize and establish policies to offset economic problems, then one would hypothesize that higher IQ countries should, on average, experience lower volatility in economic growth. I test that hypothesis using a large sample of countries.

The format of the paper is as follows. The next section provides the model tested and a description of the data used. I test the hypothesis that higher IQ countries experience less volatility in economic growth in the third section, and provide several alternative results to assess the robustness of the findings. This is followed by a discussion of the results, with the last section closing the paper.

THE MODEL AND DATA

Previous work exploring the link between IQ and economic activity has exploited a standard model of economic growth given by the equation

$$Y = A\,(K, L) \tag{1}$$

where Y represents output (real GDP per capita), K is physical capital, L is labor, and A is total factor productivity. In this set up, the effects of IQ influence growth mainly through a combination of changes in total factor productivity and the human capital component of labor. Higher IQ countries are better able to coordinate the arrangement of capital and labor in ways that increases productivity, sometimes thought of as output per worker. Earlier work such as Mankiw, et al. (1992) focused on education (i.e., years in school) as the best proxy for human capital development, a factor in improving total factor productivity. Jones and Schneider (2006) forcefully showed that IQ is likely to be a more robust measure to represent this effect.

While this description is a highly stylized one, it captures the gist for why higher IQ countries tend also to have higher rates of economic growth. Asking how IQ might affect economic growth *volatility*, however, puts us into unchartered waters. As Easterly, et al. (2003, p.5) put it, "There is little empirical or theoretical work on what might determine volatility in growth rates." Because the effects of these (and other) factors "are, on theoretical grounds alone, ambiguous," I rely on existing empirical results to determine the baseline model and the variables to include in my sensitivity analysis. Easterly, et al. (2003) and work that is more recent find that some combination of trade, financial system development, and some measure of inflation volatility account for observed volatility in annual real GDP growth rates. Easterly and Kraay (2000) used an even narrower set of variables: whether the country is an oil exporter, some measure of trade/openness, and population. For their sample of countries, this handful of variables explains about half of the variation in the growth volatility. To start my analysis I adopt this parsimonious specification as the baseline model against which I test for the significance of IQ. I then extend the model to include a variety of other variables to test the robustness of the results for IQ.

To test whether IQ helps explain economic volatility I estimate the regression:

$$VOL_i = \alpha + \beta_1 \, IQ_i + \beta 2 \, Controls_i + \varepsilon_i \quad (2)$$

where VOL_i is the volatility of the annual growth rate in real GDP per capita for country i, IQ is the ith country's national level IQ as defined by Lynn and Vanhanen (2012), "Controls" is a set of conditioning variables, α and β are parameters to be estimated, and ε is the error term of the regression. Let us consider each in order.

Output Volatility

I use the coefficient of variation to measure the volatility in the annual average growth rate of real GDP per capita, measured in constant 2010 U.S. dollars. The source is *World Development Indicators*, accessed in September 2017. I impose the *ad hoc* constraint that only countries with data from 1980 onward are included in the sample. This constraint ensures that the sample period is long enough to incorporate a series of recessions and booms, without putting undue weight on any one period of economic tranquility or hardship. I recognize that my sample includes the downturn that began in approximately 2007 and ended at various times for many countries. I have not explored the effect on our results of stopping the sample prior to the downturn. It also increases the sample of countries, because data for the pre-1980 period is limited. In addition, it means that I use data for a consistent period for all countries. For the vast majority of countries the data runs through 2016, though for a few countries the data ends one or two years earlier.

My choice of the coefficient of variation needs some explanation. An alternative is to measure volatility is the standard deviation of annual growth rates in real GDP per capita. The standard deviation is problematic if the mean values are not equal, and it is sensitive to outliers. There are 29 countries, or about 25 percent, in the sample whose mean growth rate is outside a one standard deviation band around the sample mean.

Using the standard deviation also ignores the importance of considering the *relative* size of growth volatility. Mobarak argues that "Volatility [in real growth] is of greatest concern when growth has the potential to become negative. In other words, variability of growth around 0% is *more detrimental* to development than variability around 4%." (Mobarak, 2005, p. 352, emphasis added) Consider two countries that have the same standard deviation in their respective real GDP growth rates, say 4. If the average growth rate in country A is 2 percent and in country B it is 8 percent, the standard deviation will miss the significant differences in relative magnitude of volatility. This is a concern for my sample: There are 23 countries with average annual growth rates that are less than one percent, and six of these have averages less than zero. I use the coefficient of variation because it captures the greater *relative* changes in the volatility of output growth.

National IQ

The national average IQ data, taken from Lynn and Vanhanen (2012) (hereafter, LV), represent the most recent version of their IQ series (Lynn and Vanhanen, 2002; 2006). These data include adjustments due to Lynn and Meisenberg (2010a). Others discuss the IQ data in detail, so mine is brief.

The IQ data are an aggregation of existing cognitive test scores, including journal articles and actual samples of cognitive scores, from individual countries. LV use these inputs to create an IQ "profile" for a country. When there are multiple estimates for a given country, LV use an average. When there are multiple inputs over time, LV account for any potential Flynn Effects by adjusting the raw data for the upward trend in nation-level IQ scores. To control for this, LV adjust the IQ scores to bring them into alignment at a point in time. For example, a country's IQ score in 1960 is adjusted to make it "equivalent" to the outcome from a similar test given in 1980.

The LV data have been criticized on several fronts. One important issue is the accuracy of the LV IQ statistics for Sub-Sahara African countries. Wicherts, et al. (2010a, b) argue that the LV *underestimate* IQ measures for Sub-Saharan countries. Lynn and Meisenberg (2010b) and Lynn and Vanhanen (2012) provide counter arguments. Jones and Potrafke (2014) also note that the sampling bias inherent in Wicherts, et al. approach—they focus on healthy Sub-Saharan populations of higher socio-economic status—could just as easily *overestimate* of the average IQ. Rindermann's (2013) recent analysis of African cognitive measurement also is worth noting in this regard. In no paper that I am aware of has any adjustment to the Lynn-Vanhanen IQ scores for these countries resulted in any change in the qualitative effects of IQ on economic outcomes (e.g., Jones and Schneider, 2010; Hafer and Jones, 2015; Hafer, 2017). Even so, I deal with this potential issue later in the sensitivity analysis.

To validate the IQ measure and put it into the broader perspective as a possible measure of human capital development, much work compares the Lynn-Vanhanen IQ data to other indicators of cognitive development, such as standardized test results (Rindermann, 2007; Lynn and Meisenberg, 2010; Jones and Potrafke, 2014). The results generally indicate that IQ, in the spirit of Hanushek and Kimko's (2000) use of international standardized test scores, is an indicator of a nation's aggregate human capital.

Controls

The set of controls used is a relatively small set of variables. Following Easterly and Kraay (2000), one variable included is whether the country is an oil exporter or not (OIL). An oil exporter is a country where, on average, fuel accounts for more than 50 percent of total exports. It was not uncommon to exclude oil-producing countries from estimations of economic growth, based on the argument that oil is an extractive industry and does not, therefore, increase value added, which is the foundation of GDP measurement. (Mankiw, et al. 1992) Modern estimations of growth models do not segregate oil-exporters and non-exporters into different samples, however. The approach here is to include a dummy variable for oil-exporting countries in the regression to account for differences in the volatility of growth. This is the approach taken in Easterly and Kraay (2000) and Easterly and Levine (2001). The data used to identify oil exporters is the average over the period since 1980. The source of the underlying data is the *World Bank Development Report*.

There is a large literature that explores the economics of small-states, usually defined as a country in which the population is 1 million or less. (Easterly, et al. 2003; Easterly and Kraay, 2000 and the references cited therein). The idea is that small countries may lack the resources to achieve the growth rates of larger countries. And there is some evidence that small states may be subject to more economic buffeting due to, for example, trade openness. In this study, I control for country size by using the logarithm of population (POP). Easterly and Kraay (2000) report that this gives them the same empirical outcome as using a simple (1,0) dummy variable based on having an average population less than or greater than 1 million. I use the World Bank's *World Table* to calculate the average population size since 1980.

It is common in studies investigating the causes of growth volatility to include some measure of trade openness (e.g., Easterly and Kraay, 2000; Easterly, et al, 2003; Haddad, et al, 2013). This is because trade, while it usually enhances economic growth, also exposes countries, especially small countries, to external shocks that may increase growth volatility. There are many possible ways to measure trade. I use the Freedom to Trade Index (TRADE), calculated by the Fraser Institute as part of its Economic Freedom of the World Index (EFWI). (Gwartney, et al, 2017) This is a more comprehensive measure than, say, shares of trade in GDP or terms of trade, two variables sometimes used in previous analyses. For instance, the Fraser trade index incorporates a country's tariff policies, the extent of its barriers to trade, the use of black-market exchange rates, capital controls, and controls on the movement of individuals. Since the goal of the trade/openness variable is to control for the shocks emanating from the external sector of the economy, the scope of this measure makes it more than adequate. The trade index, which runs from zero (worst) to 10 (best), is averaged over the period since 1980. Because the early indexes were calculated only every five years, I adopt the approach of averaging the values every five years between 1980 and 2015.

Lastly, I include a set of regional controls to account for any geographical differences that may explain growth volatility. Previous work in growth economics (Sala-i-Martin, 1997; Sala-i-Martin et al., 2004; and Jones and Schneider, 2006) finds that regionals help explain cross-country differences in economic growth. The dummy variables used here cast a wider net than often used, as suggested by Malik and Temple (2009). They include Asia, Middle East and North Africa, Europe, North America, Central America and the Caribbean, South America, Sub-Saharan Africa, and Australia and Oceania. Including a broad set of regional dummies also is important given the argument that IQ is distributed geographically (Gelade, 2008; Chen and Luoh, 2010; and Hassell and Sherratt, 2011). Accounting for geographical distinctiveness allows me to better assess the independent effects of IQ.

Descriptive Statistics

Table 1 provides a summary of the variables used in estimating equation (2). Data availability determines the countries that comprise the sample. It is necessary to use the same countries in order to make valid comparisons of results across specifications. My starting sample of countries was reduced once the criterion that those countries with real GDP per capita data at least from 1980 onwards would be included. Combined with availability of IQ and the control variables, the final sample is 115 countries.

TABLE 1
DESCRIPTIVE STATISTICS

Variable	Mean	Std. Dev.	Min	Max	Obs
CV	2.94	2.67	0.61	12.42	115
IQ	84.42	11.42	60.10	107.10	115
OIL	0.11	0.31	0.00	1.00	115
POP	15.84	1.81	11.14	20.79	115
TRADE	6.49	1.42	1.76	9.59	115
EDUC	5.33	2.73	0.62	12.03	103
SUM	6.21	0.98	3.90	8.96	115
GOV	5.96	1.19	2.55	9.25	115
MONEY	7.25	1.46	2.77	9.64	114
REGS	6.47	1.10	4.02	9.06	115
LEGAL	5.07	1.66	1.95	8.31	115
DEP/GDP	45.33	41.74	3.87	301.45	112

Notes: Variables are defined in the text.

A few highlights. Average IQ is 84, running from a low of 60 for Malawi to a high of 107 for Singapore. This is consistent with previous studies, all using slightly different samples, as is the standard deviation of IQ (11.42). The coefficient of variation (CV) ranges from Korea's 0.61 to Venezuela's 12.42. The average country scores about 6.5 (on a zero to 10 scale) for the Fraser Institute's trade measure (TRADE). Hong Kong claims the highest score in terms of trade openness (9.59) and the lowest score is for Myanmar (1.76).

I also report summary statistics for variables used (and defined) later in my sensitivity analysis. The one variable that stands out in Table 1 is the deposits-to-GDP ratio (DEP/GDP). This variable, used to measure financial development, has quite a large range; from 3.87 percent in the Congo to 310.45 percent for Luxembourg. I will have more to say about this in a later section. The average level of education for those 15 years and older (EDUC) is a little over five years. All of the Fraser Institute freedom measures used in the sensitivity analysis have averages around five, based on a zero-to-10 scale. Hong Kong claims the highest score in the overall level of economic freedom (SUM) of 8.96, and the Congo has the lowest score at 3.90.

Bivariate correlations between all of the variables are in Table 2. The correlations indicate that IQ and growth volatility are negative, and are significant. It also is apparent that there is a high correlation between IQ and several of the other explanatory variables. This is consistent with previous studies: high IQ countries, in general, tend to have good economic outcomes: more trade, more developed financial systems, sounder monetary policies, few regulations and better legal systems.

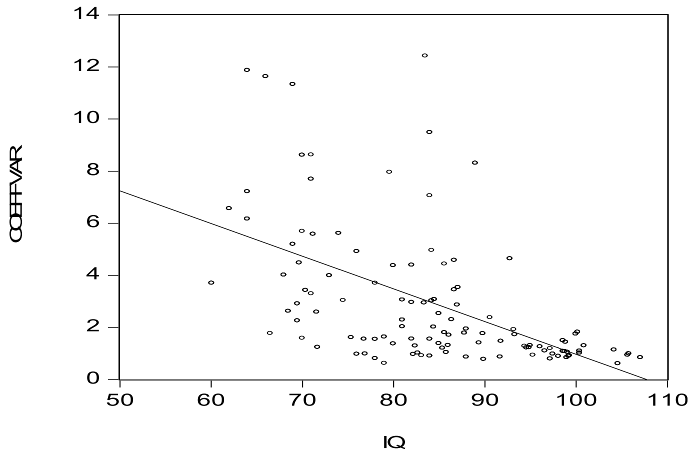
TABLE 2
CORRELATIONS

VARIABLE	CV	IQ	OIL	POP	TRADE	SUM	GOV	MONEY	REGS	LEGAL	EDUC	DEP/GDP
CV	1											
IQ	-0.54	1										
OIL	0.32	*-0.11*	1									
POP	-0.21	0.18	*-0.04*	1								
TRADE	-0.36	0.59	-0.2	-0.16	1							
SUM	-0.45	0.65	-0.22	-0.23	0.87	1						
GOV	*0.07*	*-0.15*	*-0.14*	*-0.07*	0.16	*-0.08*	1					
MONEY	-0.39	0.57	*-0.09*	*-0.02*	0.69	0.81	-0.17	1				
REGS	-0.32	0.35	*-0.05*	-0.21	0.68	0.85	*0.05*	0.58	1			
LEGAL	-0.48	0.76	-0.17	*0.04*	0.73	0.82	-0.29	0.66	0.63	1		
EDUC	-0.39	0.73	*-0.1*	*-0.05*	0.64	0.68	-0.23	0.53	0.54	0.74	1	
DEP/GDP	-0.35	0.57	*-0.12*	*-0.1*	0.56	0.61	*-0.09*	0.53	0.45	0.58	0.5	1

Notes: Correlations in italics are insignificant at the 10 percent level or better.

Figure 1 provides a visual assessment of the negative correlation between IQ and growth volatility. This simple test does not reject the hypothesis that, on average, higher IQ countries are more likely to experience lower growth volatility. The correlation between IQ and growth volatility is encouraging, but it ignores other factors that could influence the relationship.

FIGURE 1
SCATTER PLOT OF OUTPUT VOLATILITY (COEFFVAR) AND IQ



This figure shows the relationship between the volatility (CoeffVar) in the annual growth rate of real GDP per capita and national average IQ for 115 countries.

REGRESSION RESULTS

This section reports estimates of equation (2) and its variants to assess the role of IQ in explaining the volatility of real GDP per capita growth. All equations include a constant term and regional dummies, where I omit the dummy variable for North America and Europe from the regression. The regressions use White's (1980) correction to achieve heteroskedasticity-consistent standard errors.

The first column of results in Table 3 presents the estimates for the "baseline" model. These results qualitatively match those reported in earlier studies. That is, oil-exporting countries (OIL) tend to have significantly greater volatility in output growth rates compared to non-oil exporting countries. The negative (and significant) coefficient on the population variable (POP) indicates that small countries tend to have higher levels of growth volatility. The baseline model also shows that greater trade (TRADE)—more openness, fewer restrictions on the movement of capital, etc.—is associated with less output volatility across countries. This again is consistent with previous work (e.g., Easterly and Kraay, 2000; Easterly, et al., 2003; Haddad, et al., 2012). The standardized coefficients, reported in brackets, indicate that the trade and oil exporter variables have about the same impact on volatility, with population a close second. Overall, the baseline model explains about 30 percent of the variation in the output volatility, and the regression is significant: the F-statistic (6.38) is significant at better than a one percent level.

TABLE 3
REGRESSION ESTIMATES DEPENDENT VARIABLE: COEFFICIENT OF VARIATION

Variable	**Model 1**	**Model 2**
OIL	2.210**	2.257**
	-1.087	-1.043
	[0.255]	[0.260]
POP	-0.255**	-0.188*
	-0.117	-0.115
	[-0.173]	[-0.127]
TRADE	-0.434***	-0.178
	-0.163	-0.065
	[-0.230]	[-0.094]
IQ		-0.082***
		-0.029
		[-0.350]
Summary Statistics		
Adj-R^2	0.298	0.329
F-statistic	6.38***	6.59***

Notes: All regressions include a constant term and regional dummy variables. Variables are defined in text. All regressions estimated using White heteroskedasticity-consistent standard errors, which appear in parentheses under estimated coefficients. Standardized beta coefficients appear in brackets. Significance at the 10 percent level is indicated by *; at the five percent level by **; and at the one percent level by ***.

I now use the baseline results to test whether IQ has a significant, independent effect on growth volatility. These results are in the second column of Table 3. The first thing to notice is that including IQ affects other variables' coefficient estimates. The oil exporter dummy (OIL) is still significant at the five percent level and the standardized coefficient is little changed. Adding IQ reduces the significance of the population variable (POP), though it remains significant at the 10 percent level. IQ does, however, render the trade variable (TRADE) statistically insignificant. This may not be too surprising considering that the correlation between TRADE and IQ is 0.60, significant at the five percent level (see Table 2).

What do the results say about IQ? The estimated coefficient on IQ reported in Table 3 is negative and highly significant. This finding does not reject the hypothesis that countries with higher levels of national IQ, holding constant the effects of the other control variables (including regional dummies), on average have lower levels of growth volatility. It also appears that IQ is the most important variable in terms of effect: the standardized coefficient for IQ is 0.35, which is noticeably larger (in absolute value) than any of the other control variables. The result for IQ indicates that raising IQ by about one standard deviation lowers the output volatility by about one percentage point (0.93 = 0.082 x 11.42), or a little over 30 percent when evaluated at the mean of the volatility measure (= 2.94). Including IQ in the baseline regression also raises the overall explanatory power of the model (the adjusted R^2) by about 10 percent, to 0.329 percent from 0.298 percent. IQ is not only a statistically significant, but also an economically significant in explaining cross-country variation in growth volatility.

Robustness Tests

I now turn to estimating alternative versions of equation (2) in an attempt to see how sensitive the estimated effect of IQ is to changes in the regression specification. At the outset, let me be clear about the purpose of these tests: It is not to find the most appropriate model for estimating growth volatility. My task is see whether adding a reasonable set of additional variables to the model affects the size, sign, and statistical significance of IQ. In this spirit, and to conserve space, Table 4 reports the estimated coefficient, standard error, standardized coefficient only for IQ along with the summary statistics for each of the alternative specifications. (Full regression results are available upon request.)

Alternative Cognitive Skills Measures

I noted earlier that a criticism of the LV national IQ measure is that it may understate IQ in Sub-Saharan Africa. In some studies (e.g., Hafer and Jones, 2015; Hafer, 2017) this concern was dealt with in a brute force manner by simply setting the IQ score in those countries to 80, which is approximate average reported in Wicherts, et al. (2010a, b). This approach has not altered previous findings: the LV version of national IQ remains significant. Such an *ad hoc* approach seems difficult to justify, especially given the damaging criticisms leveled by Jones and Potrafke (2014).

To assess the sensitivity of using the LV IQ data I substitute the IQ series calculated in Rindermann (2013) for the LV data. The outcome is in the first row of results in Table 4. Using the Rindermann IQ measure (Rind IQ), growth volatility again is related negatively to IQ at a high level of statistical significance. In addition, the standardized coefficient (reported in brackets) indicates that differences in IQ are important in accounting for differences in growth volatility across countries. As before, the overall regression explains slightly more than a third of the variation in growth volatility.

A demanding test of the IQ results is to account for education. Jones and Schneider (2006) found that even though IQ was robust to its inclusion, a variable for educational attainment provided additional explanatory power to a model of differences in economic growth across countries. In a study related to this one, Mobarak (2005) found that economic volatility was negatively related to higher levels of educational attainment.

To see if the estimated effect of IQ is sensitive to the presence of an education-based measure of human capital, I included the oft-used Barro and Lee (2013) measure of average years of schooling for individuals aged 15 years and more (EDUC). To match this measure up with IQ, I used the data for 1980. As reported in Table 1, the mean number of years of education is 5.22 with a wide range.

The results of this experiment are in the second row of results in Table 4. Adding the educational attainment measure has little effect on the estimated coefficient for IQ: the estimated coefficient is only slightly smaller than that found in Tale 2 (-0.079 vs. -0.082, respectively), and it is statistically significant at the five percent level. In a sense, IQ "dominates" educational attainment. This finding, I believe, is important. It is important because when IQ is excluded from the regression, the estimated EDUC coefficient is negative (-0.216) and highly significant (pr = 0.008). This outcome qualitatively matches that of Mobarak (2005) even though they are based on a different set of countries, controls, and dependent variable (he uses the standard deviation of GDP growth). If IQ is merely "standing in" for education, and the fact that education is a normal good—as incomes rise the demand for it increases—then finding that IQ plays an independent role in explaining cross-country differences in economic volatility suggests that IQ represents more than the increase in education that accompanies overall economic development. Differences in IQ apparently are accounting for something that is distinctly different from differences in education.

TABLE 4
SENSITIVITY ANALYSIS
DEPENDENT VARIABLE: COEFFICIENT OF VARIATION

Variable added	IQ Coefficient	SEE	Std. Beta	Summary Stats Adj-R2/F
Alternative Cognitive Skills				
Rind IQ	-0.079***	0.029	-0.360	0.331/6.65
EDUC	-0.079***	0.039	-0.369	0.361/6.23
Institutions				
SUM	-0.052*	0.033	-0.228	0.357/7.33
GOV	-0.081***	0.029	-0.348	0.322/5.93
MONEY	-0.072**	0.031	-0.308	0.333/6.14
REGS	-0.078***	0.028	-0.333	0.378/7.31
Legal System				
LEGAL	-0.059*	0.036	-0.256	0.331/6.13
ORIGIN	-0.096***	0.033	-0.410	0.321/4.86
Financial Development				
DEP/GDP	-0.075***	0.030	-0.321	0.318/5.70
Log(DEP/GDP)	-0.048*	0.028	-0.205	0.363/6.74
Adj (DEP/GDP)	-0.067**	0.031	-0.286	0.318/5.54

Notes. This table reports **only** the estimated coefficient on IQ after including the variables listed in the first column to the regression in Table 3. Variables are defined in text. All regressions include a constant term and regional dummy variables. All regressions estimated using White heteroskedasticity-consistent standard errors, reported as SEE. Std. Beta is the standardized coefficient for IQ. Significance at the 10 percent level is indicated by *; at the five percent level by **; and at the one percent level by ***. All reported F-statistics are significant at the one-percent level.

Institutions

Several studies find that improved democratic institutions and/or smaller size of government tends to lower growth volatility. I pursue this line of enquiry by testing the sensitivity of IQ to the inclusion of several "institutional" measures. Here I use the term "institution" to represent a broad array of "economic" forces that affect outcomes. In effect, institutions are the "rules of the game" (North, 1994) within which actions by individuals and governments determine economic outcomes. For example, the degree of governmental intervention in an economy is one "institutional" factor to consider. Another is the extent and protection of property rights. Dawson (2010, 2015) discusses and provides examples of testing for the effect of institutional variables on economic volatility.

To test the robustness of IQ to the inclusion of various institutional measures I use the summary measure of the EFWI (SUM) and the other four component indexes, trade having been used. For each measure, I use the average over the period 1980 to 2015. As with TRADE, the EFWI measures are on a zero to 10 scale, with 10 indicating "most free." Summary statistics and correlations for these variables are in Tables 1 and 2, respectively.

What is the effect on IQ from adding an overall institutions measure (SUM) to the regression? I should note that due to the significant degree of correlation between the SUM and TRADE measures (r = 0.87), and the simple fact that TRADE is a subcomponent of the SUM measure itself, I drop TRADE in these regressions. I also should note that leaving TRADE in the regression does not affect the outcome as it pertains to IQ. In this alternative baseline model—excluding TRADE and including SUM—the other controls maintain sign and significance, and the estimated coefficient on SUM is -1.039, which is statistically significant at better than the one-percent level (t = 3.30). When I add IQ to this model, the coefficient on SUM maintains its sign but its significance falls to the six percent level. This suggests that both measures probably are capturing similar "good" institutional effects associated with lower economic volatility. More importantly, when SUM is present the coefficient on IQ is negative (-0.052) and statistically significant at the 10 percent level. (See Table 4) The impact of a change in IQ is somewhat smaller than reported in Table 3 when the SUM variable is included. Still, the fact that IQ is negative and is statistical significant in the presence of SUM is noteworthy.

I now consider the effect of adding each of the various sub-components of the overall EFWI index by adding each subcomponent of the EFWI index to the model reported in Table 3. The component measures are Size of Government (GOV), Money (MONEY), and regulations (REGS). As before I average the values of this component over the period since 1980, using reported values every five years. Tables 1 and 2, respectively, provide the relevant summary statistics and correlations for these variables.

The size of government component (GOV) captures the size and influence of government on the economy. The philosophy behind this measure is that as "government spending, taxation, and the size of government-controlled enterprises increase, government decision-making is substituted for individual choice and economic freedom is reduced."(Gwartney, et al., 2017; p. v) Values of government consumption, transfers and subsidies, government enterprises and investment, the top marginal income tax rate, and the top payroll tax rate comprise GOV. The larger the influence of the government—more government spending relative to GDP, the higher are taxes, etc.—the lower is the value of GOV. Though Dawson (2010) and Jetter (2014) found that GOV and growth volatility to be positively correlated, for my sample the simple correlation is not statistically different from zero (Table 2).

Including GOV in the model produces an estimated coefficient on GOV that is positive (0.012), though statistically insignificance at any reasonable level. Dawson (2010) finds that and increase in GOV is associated with a statistically significant increase in economic volatility. Our differing results could be due to the fact that he uses the standard deviation of real GDP growth rates, a different sample (1980-2007), and a smaller sample of countries (N= 85). If IQ is excluded from my regression the estimated coefficient on GOV is positive (0.056) but it remains statistically insignificant (pr = 0.75). A similar result occurs even if I exclude the TRADE measure. More importantly, does adding GOV to the model affect the estimated coefficient for IQ? As shown in row three of Table 4, the estimated coefficient on IQ with GOV present is almost identical in magnitude as in Table 3 (-0.081 vs. -0.082), significant at the one percent level. The standardized coefficient also indicates that a change in IQ continues to exert an economically important effect on growth volatility.

Governments and central banks that engage in highly inflationary policies might destabilize output growth. I control for this possibility by including the Money component from the EFWI. MONEY measures how a country's monetary policies affect price stability. A higher rating is obtained when a country's monetary authority (or government) follows "policies and adopt[s] institutions that lead to low (and stable) rates of inflation and avoid regulations that limit the ability to use alternative currencies."(Gwartney, et al, 2017, p. 5) Money growth, the rate of inflation and its standard deviation, and an individual's freedom to own foreign currency bank accounts are considered when calculating this index. With Easterly, et al.'s (2003) finding that growth volatility is positively correlated with volatility in inflation and money growth, a higher value for the MONEY component (a higher score indicates less volatility in money growth and inflation) should be consistent with lower growth volatility.

The estimated coefficient on MONEY is negative (-0.353) and significant at the 10 percent level (pr = 0.09) when it is included in the baseline model without IQ. (The sample size for this regression is 114: I exclude Guatemala for lack of data on MONEY.) When IQ is added to the regression, the coefficient on IQ reported in Table 4 is still negative and significant at the five percent level. IQ thus continues to be a key explanatory variable in the model as evidenced by its standardized coefficient (-0.308).

Is IQ robust to including a measure that accounts for the degree of regulation in an economy? The regulations component (REGS) of the EFWI accounts for the degree of regulation across the economy, covering credit and labor markets, and general business regulations. A country receives a lower score if it has higher levels of administrative requirements, bureaucracy costs, greater difficulty starting a business, the prevalence of bribes and favoritism, greater licensing restrictions, and higher cost of tax compliance. Arguably, the greater is the degree of regulation the more likely it is that a country will experience higher output volatility: The tangle of bureaucracy may impede market forces or government policies from adjusting to output shocks in an efficient and timely manner. The expected sign on REGS is negative.

When REGS is added to the baseline model, its estimated coefficient is negative (-0.915) and significant at the one percent level, similar to the result reported by Dawson (2010). Adding IQ to this model produces a coefficient on IQ again is negative (-0.078) and significant at the one percent level (see Table 4). It turns out that the magnitude of effect from a change in IQ and regulations, based on the standardized coefficients, is about the same.

The results in this section indicate that the empirical relationship between IQ and growth volatility is robust to including several institutional measures, from the portmanteau SUM measure to more specific measures that account for size of government, monetary policy, and the regulatory environment.

Legal Systems

I now consider the effect that a country's legal system might have on the relationship between IQ and growth volatility. There is considerable evidence that a country's legal system, especially the existence of and protection of property rights is an important factor explaining economic success. (e.g., Dawson, 2010 and references cited therein). To see if accounting for legal system affects the effect of IQ, I use two approaches. The first is to include the EFWI's component "Legal System" (LEGAL) in the model. The other is to account for a country's legal origins.

LEGAL accounts for various aspects of a country's legal system: the independence of its judiciary, the protection of property rights, legal enforcement of contracts, and military influence in the rule of law and politics. As the developers of the EFWI argue, "Protection of persons and their rightfully acquired property is a central element of economic freedom. Many would argue that it is the most important function of government." (Gwartney, et al, 2017, p. 3) When the regression is estimated without IQ present, the estimated coefficient on LEGAL is -0.487, which is significant at better than a five percent level (pr = 0.025). This is similar to Dawson's (2010) finding that countries with "better" legal systems tend to have more stable economies. Adding IQ to the model produces the estimated coefficient in Table 4 that is once again is negative (-0.059) and statistically significant. This regression, the coefficient on LEGAL is negative, but not significant. The effect of a change in IQ on growth volatility given the effects of LEGAL remains economically important as suggested by its standardized coefficient on IQ.

I also investigate the effect of accounting for legal origin. A country's legal origin establishes the cultural and legal atmosphere in which laws were written. This may be especially important for financial markets. La Porta, et al. (1997, 1998) found that common law countries—those founded on English legal traditions—tend to pass laws that generally are more protective of investors. Countries in which the legal system is based on civil law, such as the French legal tradition, do not. The summary by La Porta, et al. (2008) indicates that legal origin also explains differences in other areas, such as government regulation of the media, labor laws, corporate law, and government ownership of banks.

If legal origin effects the development and workings of a country's financial system and thus economic growth (Levine, et al., 2000), it could help explain differences in growth volatility. To identify a country's legal origin I use Reynolds and Flores (1996) inventory, with any country not in their set defined using Treisman (2007). Legal origin is a (0,1) variable taking on a value of one assigned to four possible traditions—English, French, German, Scandinavian, or Other—and zero otherwise. In my regressions, I hold out the legal origin variable for English.

Though not reported here, I should note that the estimated coefficients for French and German legal origins are all positive, suggesting that, all else the same, these countries tend to have greater growth volatility than those countries with an English legal tradition. The estimated coefficient for Scandinavian and Other legal traditions is negative. For the purpose at hand, the estimates in Table 4 indicate that including IQ in a model that includes these various legal origins (ORIGINS) produces an estimated coefficient on IQ that is negative (-0.096) and significant at the one-percent level. The standardized coefficient on IQ again shows that the relative effect of a change in IQ remains significant.

The results of including some measure of a country's legal system indicate that growth volatility remains negatively and significantly related to IQ.

Financial Development

Several researchers (e.g., Easterly, et al., 2003; Haddad, et al., 2012) find that financial development and growth volatility are related. This is because financial institutions play a central role in how individuals, firms, and even governments cope with economic shocks. Levine, et al. (2000), among others, find that economic growth and financial development are positively related. Hafer (2013, 2016) reports that both economic freedom and IQ influence the development of financial institutions. Because financial markers distribute risk, the existence of this cushion should reduce volatility in output growth. Thus, financial development and growth volatility are likely to be negatively related. Accounting for the effects of financial development may be an important in determining the independent effect of IQ on growth volatility.

I use the ratio of deposits to GDP (DEP/GDP) to represent financial development. The ratio is the total value of demand, time and saving deposits at domestic deposit money banks as a share of GDP. Deposit money banks are commercial banks and other financial institutions that accept transferable deposits, such as demand deposits. This ratio is often used (e.g., Hafer, 2016 and the articles cited therein) to compare the degree of financial development across countries. Alternatives are a measure of liquid liabilities and one measuring holdings of private credit. Since the correlation between these measures and the deposits-to-GDP ratio is positive and significant, using the ratio seems adequate. It also increases the sample size. Using data available from the IMF's *International Financial Statistics*, financial development is the annual average of the deposits-to-GDP ratio since 1980. Because of data limitations, the sample is reduced by three countries compared with those in Table 3. Those countries are Albania, Iceland, and the United Kingdom.

The effect on IQ of adding the financial development variable to the model is reported in the bottom panel of results in Table 4. I report three outcomes. This is because in the initial estimation of the model that includes the DEP/GDP ratio (omitting IQ) the estimated coefficient on financial development was negative (-0.007), as expected, but statistically insignificant (pr = 0.12). This may not be too surprising given the huge variation in the series, as reported in Table 1. To test whether this wide range explains the lack of significance, I then tried two variants. One was to use the log of the ratio. When log (DEP/GDP) is used, the estimated coefficient is negative (-1.39) and highly significant (pr = 0.002). The other approach was to remove the countries that were obvious outliers: greater than three-standard deviations from the mean. Removing these countries, namely, Cyprus, Hong Kong, Japan, and Luxembourg, yields an estimated coefficient on DEP/GDP of -0.026, which is significant at the two percent level (pr = 0.019). When estimated without IQ present, these latter two approaches produce estimates on the DEP/GDP ratio that conform to previous work: the greater the level of financial development, the lower is growth volatility.

The results in the bottom panel of Table 4 reveal that after giving financial development sufficient opportunity to influence economic volatility, the estimated coefficient on IQ continues to be negative and statistically significant. Only when I use log (DEP/GDP) is IQ's statistical effect diminished, though it is still significant at the 10 percent level (the actual significance level is 8 percent). Even so, the standardized coefficient indicates that a one standard deviation change in IQ has a significant effect on growth volatility.

DISCUSSION

Volatility in the growth of real GDP per capita and IQ have a significant, negative correlation across a large sample of countries. I have subjected this relationship to a battery of alternative specifications to assess how sensitive it is to controlling for a variety of other factors. These include country size, trade openness, whether the country is more prone to external shocks (oil exporter), levels of educational attainment, broad institutional measures to control for size and reach of government, monetary policy, regulatory environment, two variations to hold constant the characteristics of the legal system, and differences in financial development. My choice of controls and additional variables is entirely consistent with the categories used in previous work. (e.g., Mobarak, 2005) Even after accounting for the role that these other factors may have in explaining growth volatility, my results indicate that countries with higher national level IQ on average have significantly lower growth volatility. Equally important, in no instance does adding this host of other controls render IQ statistically insignificant at any reasonable level. At least for my sample of countries and for the time-period studied here, I cannot reject the hypothesis that IQ is a robust estimator of differences in the cross-country volatility of real GDP growth.

Could IQ represent a "deep" structural variable when it comes to explaining economic outcomes? Some economic growth researchers have considered deep historical factors—history of institutional development, agriculture, and advances in technology, among others—to explain understand differences in observed economic growth patterns. (e.g., Acemoglu, et al., 2005; Galor and Moav, 2002; Tang, et al., 2016) As Jones and Schneider (2006, p.89, f.4) note, "In their [Galor and Moav] model, the Malthusian era favors the transmission of pro-human-capital-investment genes. They focus on the experience of Western Europe; extending their model to the rest of the world could help explain why average IQ differs so much across countries." I leave that possibility for future analysis.

What limits this analysis is the nagging problem of endogeneity. National IQ is the product of many previous years of economic, cultural, and intellectual development. Since the LV national IQ data are of fairly recent creation, it could be argued that the relative levels of IQ are reflecting the uneven developments that took place in the not-too-distant past. That is, high nation level IQ might reflect as much the cognitive development of a country as the "good institutions"—better democracies, better legal systems, better health systems, better educational systems, etc.—that have evolved in relatively recent years. This is not to say that LV's IQ may not be a viable representation of *relative* cognitive development across countries, but it leaves room for further research aimed at trying to pin down this endogeneity problem.

CONCLUSIONS

IQ is a robust predictor of various aspects of economic activity. My focus is on the link between national IQ and economic volatility. My evidence indicates that higher IQ countries on average experience less volatility in their annual growth rate of real GDP per capita relative to lower IQ countries, even after holding constant the effects of many control variables. All else the same, higher IQ countries tend to have more stable economies.

My results fit snugly within previous work that finds that higher IQ countries experience better economic outcomes. I would argue that this manifests itself in the formation and implementation of better—growth volatility reducing—macroeconomic policies. This is consistent with the idea that nation-level IQ and good governance are positively related (Rindermann, 2018). My results also expand the set of explanations for why the volatility of policies has a significant negative effect on long-term economic performance (Fatas and Mihov, 2013), that improvements in democratic institutions and economic volatility are negatively related (Mobarak, 2005), and that higher IQ countries seem to have lower average rates of inflation (Salahodjaev, 2015).

If higher IQ is associated with the development of institutions and policies that recognize the negative effects of growth volatility on long-term economic well-being, the results in this study provide further evidence for implementing policies that improve cognitive development (human capital), especially in developing countries. Such policies could improve the prospects for greater economic stability and improved economic well-being for a country's residents.

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